

## PHYSICAL ACTIVITY IN PRE-SCHOOL CHILDREN FROM THE ASPECT OF HEALTH CRITERIA

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The main aim of this study was to assess potential differences between groups of pre-school children meeting and not meeting health recommendations for physical activity (PA) from the aspect of so called indicators of physical activity (active energy expenditure, number of steps). The number of steps was measured by Yamax Digi-Walker SW-200 pedometers (Yamax Corporation, Tokyo, Japan) and the active energy expenditure was measured by Caltrac (Muscle Dynamics Fitness Network, Torrance, California) accelerometers. Evaluation of PA from the aspect of so called health criteria was realized following the criteria of Frömel, Novosad and Svozil (1999), who recommend values of so called health criteria of PA. Meeting these criteria, it is possible to suppose that PA positively affects the healthy development of an individual. The sample consisted of 200 pre-school children. Forty nine of these children (30 boys and 19 girls) were labeled as group A (children who did not meet the recommended values at least in one of the health criteria of PA). Group B (children who met the recommended values at least in one of the mentioned criteria of PA) consisted of 151 children (74 boys and 77 girls). The Mann-Whitney U test was used to test the statistical significance of possible differences between groups A and B and also between boys and girls within these groups as well. In all monitored parts of a week, as well as in both monitored parts of a day, a significant difference ( $p < .001$ ) was found between groups A and B in both indicators of PA. Regarding these variables, the smallest differences ( $p < .02$ ) were observed within the time spent at school. Our results confirm that a stay at kindergarten belongs among the relevant parts of a day from the aspect of children's physical activity in the sense of a very "problematic" part of a day, when the values of active energy expenditure and steps are decreased almost by 50% even in children physically active outside the school. On the other hand, a kindergarten is a proper place for children with hypokinetic behavior, who can be activated by an adequate incidence of school physical regimen.

*Keywords: Physical activity, pre-school age, health recommendations, environmental stimulation.*

### INTRODUCTION

Movement is not only an irreplaceable factor for the creating and coordinating of the individual development of a child, but also serves as a certain criterion for the longitudinal control of dynamic changes in child growth and development. At present, many experts (Cabrnchová, 2008; European Heart Health Initiative, 2001; Friedenreich, Courtney, & Bryant, 2001; Katzmarzyk & Janssen, 2004; Sadler, 2003; U. S. Department of Health and Human Services, 2000) point out a growing discrepancy between the phylogenetically given need for movement and a physical regimen of children, which could negatively affect the health status of an adult population in the future.

The aim of this study was to assess and analyze potential differences between groups of pre-school children meeting and not meeting health recommendations for PA from the aspect of so called indicators of PA (active energy expenditure in a  $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ , abbreviated as AEE; the number of steps in  $\text{steps}\cdot\text{day}^{-1}$ , abbreviated

as STEPS). The data were collected as a part of participation in the research grant project approved by the Ministry of Education, Youth and Sports of the Czech Republic No. 6198959221 entitled "Physical activity and inactivity of inhabitants of the Czech Republic in the context of behavioral changes", realized at Faculty of Physical Culture, Palacký University in Olomouc.

### METHODS

For the monitoring of PA, the following combination of techniques was used:

The 1<sup>st</sup> indicator of PA - STEPS ( $\text{steps}\cdot\text{day}^{-1}$ ): was measured by Yamax Digi-Walker SW-200 pedometers (Yamax Corporation, Tokyo, Japan); whereas the 2<sup>nd</sup> indicator of PA - AEE ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ): was measured by Caltrac (Muscle Dynamics Fitness Network, Torrance, California) accelerometers.

With regard to anticipated difficulties related to using these devices in a group of a given age (Bayer et al.,

2008; Metallinos-Katsaras, 2007), the measurements were preceded by motivating the children to learn how to carry the devices and how to not misuse them. In agreement with general recommendations (Armstrong et al., 1998; Lin et al., 2007; Pratt, Macera, & Blanton, 1999; Trost, McIver, & Pate, 2005; Ward, Evenson, Vaughn, Brown, & Troiano, 2006), the children wore the devices placed firmly on an elastic belt, above their clothes on the right hip. During the seven day monitoring period, the devices were taken off only at the times of sleeping and of possible contacts with water (washing, swimming, bathing, etc.). With respect to previous experiences, buttons on the accelerometers were covered by strapping, fortified by pasteboard and strapped again. Adults referred to a need of placing the devices right back into a "pocket" after recording the measured values. Each kindergarten had at its disposal the usual room conditions (game room, school playground/yard) and material conditions standard in the Czech Republic. Fully qualified teachers taught at all the involved schools. The school educational program of all kindergartens was based on the valid framework "Educational program for pre-school education" (MSMT CR, 2005). Elastic belts with monitoring devices were attached to children on the first day of monitoring in the assessment. The devices were set to zero with previously loaded data needed for the measuring (age, sex, body weight, and body height).

For any group of given age, minimum values of criteria of PA indicating a presumption of negative health impact when not meeting them are not available yet. With regard to the value of the mean age of a sample (5.71 years), the criteria of Frömel, Novosad and Svozil (1999) were used. Based on their measures, these authors recommend the following values of the health criteria of PA for individuals from the age of six, which should lead to the maintenance of health and positively affect healthy development:

- the daily active energy expenditure should be at least  $11 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  in boys and  $9 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  in girls, respectively, in a majority of the days within a week;
- the daily number of steps, hops or position changes should be, in primary school children, about 13,000 steps in boys and 11,000 steps in girls, respectively, in the majority of days within a week.

The health effect could be anticipated when at least one of these recommended values is met.

The sample consisted of 200 children of pre-school age (96 girls and 104 boys). With respect to the aim of this study, the sample was divided into two groups after the criteria mentioned above:

- group A – children who did not meet the recommended values at least in one of the health criteria of

PA (i.e. AEE: boys less than  $11 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ , girls less than  $9 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ; STEPS: boys less than 13,000 steps $\cdot\text{day}^{-1}$ , girls less than 11,000 steps $\cdot\text{day}^{-1}$ );

- group B – children who met the recommended values at least in one of the mentioned criteria of PA (i.e. AEE: boys  $11 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  and more, girls  $9 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  and more; STEPS: boys 13,000 steps $\cdot\text{day}^{-1}$  and more, girls 11,000 steps $\cdot\text{day}^{-1}$  and more).

Forty nine children (24.5%) from the sample were included into group A, 30 of these were boys (61.22%) and 19 were girls (38.78%). The mean value of their BMI was 15.70 (15.60 in girls and 15.80 in boys). One hundred and fifty one children (75.5%) were included in group B, 74 of these were boys (49.01%) and 77 were girls (50.99%). The mean value of their BMI was 15.60 (15.63 in girls and 15.58 in boys). Regarding the diagrams for the calculation of the BMI of children in the Czech Republic (Vignerová et al., 2008), none of the monitored children was classified as obese.

The Mann-Whitney U test was used to test the statistical significance of possible differences between the groups A and B and also between boys and girls within these groups as well. The reason for the utilization of this test was the different variance between the compared groups.

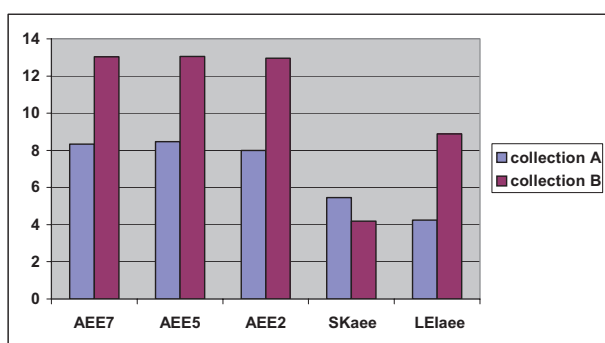
## RESULTS AND DISCUSSION

Group B reaches significantly higher values ( $p < .001$ ) in mean weekly AEE ( $\text{AEE}_7 = 13.03 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ), on weekdays ( $\text{AEE}_5 = 13.05 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) and also on weekend days ( $\text{AEE}_2 = 12.95 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) compared to group A ( $\text{AEE}_7 = 8.34 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ;  $\text{AEE}_5 = 8.47 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ;  $\text{AEE}_2 = 8.00 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). However, group A has markedly higher AEE ( $p < .02$ ) on weekdays during their stay at school ( $\text{SK}_{\text{aee}} = 5.46 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) compared to group B ( $\text{SK}_{\text{aee}} = 4.19 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). Supposedly, the school regimen of the children from group A motivates and activates them more to be more physically active. At extracurricular time, again, group A ( $\text{LEI}_{\text{aee}} = 4.24 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) is considerably less active ( $p < .001$ ) than group B ( $\text{LEI}_{\text{aee}} = 8.89 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). These results correspond to the above mentioned  $\text{AEE}_2$  of the group A. Obviously, their time spent with family is more filled with inactivity. Kindergartens are set up by the framework educational program to have sufficient room for creating a quality physical regimen for children. Nevertheless, in those monitored kindergartens, the contemporary state is insufficient for more active children and, on the other hand, leads to a decrease in physical activity during their stay at school. Within the typical school regimen of kin-

dergartens, lots of activities (e.g. time for food, rest in bed after lunch, etc.) can be characterized as “inactivity”. However, with respect to a level of the ontogenetic development of children, it is necessary to include such inactivity in a daily program. In spite of this, it can be recommended to continue with the improving of the physical regimen at monitored schools (including an individualized approach to more active children) which would be more convenient to children and lead to meeting their high requirements for movement (Fig. 1).

**Fig. 1**

The active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) – comparison of groups A ( $n = 49$ ) and B ( $n = 151$ )



Legend:

AEE 7 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) within the monitored week

AEE 5 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays

AEE 2 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekend days

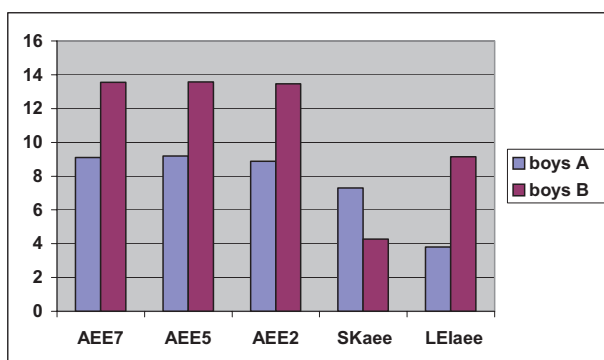
SKaee – the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays at school

LEIaee – the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays in leisure time

Boys from group B exceed significantly ( $p < .001$ ) the results of their counterparts from group A almost in all monitored variables of the AEE criterion. During the monitored week, mean values of their AEE7 reached  $13.55 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ , AEE5 was  $13.58 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  and AEE2 was  $13.46 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ . High AEE can be observed also in leisure time out of school ( $\text{LEIaee} = 9.14 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). Boys from group A reach almost values one third lower compared to group B ( $\text{AEE7} = 9.10 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ;  $\text{AEE5} = 9.19 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). On the other hand, a stay at school is exceptional from this point of view, because these boys record significantly ( $p < .001$ ) higher values of AEE ( $\text{SKaee} = 7.32 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) compared to boys from group A ( $\text{SKaee} = 4.27 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). Nevertheless, their AEE is very low outside school ( $\text{LEIaee} = 4.95 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) and similarly at the weekend ( $\text{AEE2} = 8.89 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) (Fig. 2).

**Fig. 2**

The active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) – comparison of boys from groups A ( $n = 30$ ) and B ( $n = 74$ )



Legend:

AEE 7 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) within the monitored week

AEE 5 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays

AEE 2 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekend days

SKaee – the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays at school

LEIaee – the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays in leisure time

Boys A – the sample of boys who do not meet health recommendations IAW the indicator of AEE ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ )

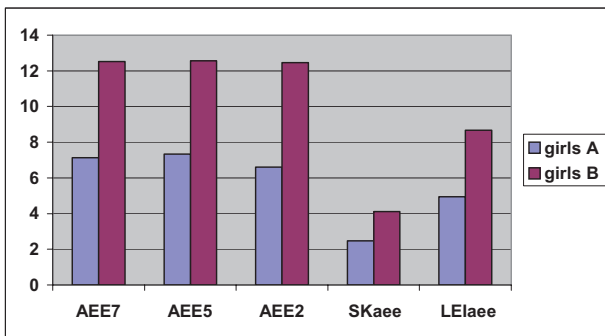
Boys B – the sample of boys who meet the health recommendations IAW the indicator of AEE ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ )

A similarly significant difference ( $p < .001$ ) can be observed in the criteria of PA AEE7 and AEE5 between the groups of girls (group B:  $\text{AEE7} = 12.53 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ;  $\text{AEE5} = 12.56 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ; group A:  $\text{AEE7} = 7.13 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ;  $\text{AEE5} = 7.34 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). A strong prevalence of inactivity in group A ( $p < .001$ ) is observed particularly at the weekend days, when group A reaches approximately half values ( $\text{AEE2} = 6.60 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ), when compared to group B ( $\text{AEE2} = 12.47 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). Girls from group A ( $\text{LEIaee} = 4.95 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) are also significantly ( $p < .001$ ) less active than girls from group B ( $\text{LEIaee} = 8.68 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) at weekdays outside school (Fig. 3). Even the school physical regimen of monitored kindergartens does not activate these girls ( $\text{SKaee} = 2.48 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ). A significant difference ( $p < .001$ ) is also found when comparing girls from group A and boys from the same group, while the intra group comparison of boys and girls ( $\text{SKaee} = 4.11 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) from group B does not generate any statistical difference.

Corbin, Pangrazi and Welk (1994) indicate the minimal daily limits of AEE  $3\text{--}4 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  while some health effects could be expected in PA lasting 60 minutes with an AEE  $6\text{--}8 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ . In the Czech Republic, the highest energy expenditure observed in

**Fig. 3**

Active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) – a comparison of girls from groups A ( $n = 19$ ) and B ( $n = 77$ )



Legend:

AEE 7 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) within the monitored week

AEE 5 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays

AEE 2 kg – mean values of the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekend days

SKAee – the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays at school

LEIaee – the active energy expenditure ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) on weekdays in their leisure time

Girls A – the sample of girls who do not meet the health recommendations IAW the indicator of AEE ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ )

Girls B – the sample of girls who meet the health recommendations IAW the indicator of AEE ( $\text{kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ )

research done by Frömel, Novosad and Svozil (1999) at primary schools was  $8.91 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  in girls and  $10.94 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  in boys.

Mean values of the monitored sample of pre-school children as a whole are higher ( $\text{AEE} = 11.98 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ; girls  $11.43 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ; boys  $12.31 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$ ) than those recommended values. The recommended value of AEE is met by 112 children (56%) from the sample, sixty three of whom are boys (57.27%) and forty nine of whom are girls (44.55%). Eighty eight children from the sample (44%) do not meet this value (41 boys, i.e. 46.59% and 47 girls, i.e. 53.41%). The high percentage of pre-school children not meeting at least minimal recommendations for AEE is surprising, with regard to the expected effects of the physical activity regimens of children in kindergartens. Neither the quantity of physical activities implemented daily into the school regimen, nor PA outside school and at the weekend days is probably sufficient to compensate for the prevalence of inactivity during other parts of each day and week. In group A, the problematic parts of a week are the weekend days and the time after school on the weekdays. At such a time, the physical regimen of a child is left to the full competency of the child's family (parents), that is why we see (in concordance with other

experts) a solution in the education of parents in the field of the importance of PA for the healthy development of a child (Kodat et al., 2006; Salonna et al., 2008; Sichieri, Taddei, & Everhart, 2000). It is necessary to prefer a fellowship of engagement in PA for children and their parents (National Center for Chronic Disease Prevention and Health Promotion, 1999). We consider quality and the qualified promoting of a healthy lifestyle within a family to be very important (Coakley, 1987), not only by means of policy, the influence of the mass media, and physicians but also by teachers at kindergartens. Similarly with Dowda, Pate, Trost, Almeida and Sirard (2004) or Timperio, Salmon and Ball (2004), we assume that it is necessary to improve the quality of the undergraduate education of kindergarten teachers. We identify with the opinion of the European Healthy Heart Initiative (2001) that school should become a center for the promotion of a healthy lifestyle for children.

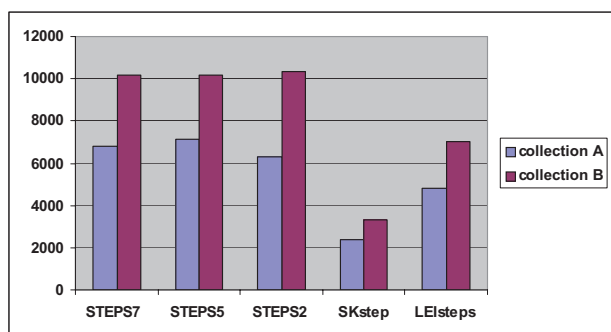
Boreham and Riddoch (2001) claim that contemporary children expend approximately  $600 \text{ kcal}\cdot\text{kg}^{-1}\cdot\text{day}^{-1}$  less energy than children 50 years ago, despite their ontogenetically given need for movement, and this trend has been increasing in recent decades. Although the health consequences of reduced energy expenditure in adulthood are very well known, associations with inactivity in childhood have not been sufficiently described yet. In particular, juvenile obesity can be followed by many negative health effects in adulthood. Experts presume an increase in the growing quantity of overweight and obese children as seen in growing numbers of victims of chronic and fatal diseases in the oncoming decade (Chinn & Rona, 2001; Lee, Burgeson, Fulton, & Spain, 2006; Pender & Pories, 2005; The United Kingdom Parliament, 2001).

Significant difference ( $p < .001$ ) between groups A and B was found also in all monitored variables of the STEPS criterion. Group A reached significantly lower values of the number of steps within a monitored week ( $\text{STEPS7} = 6817 \text{ steps}\cdot\text{day}^{-1}$ ), on weekdays ( $\text{STEPS5} = 7124 \text{ steps}\cdot\text{day}^{-1}$ ), and on weekend days ( $\text{STEPS2} = 6307 \text{ steps}\cdot\text{day}^{-1}$ ), when compared to group B ( $\text{STEPS7} = 10182 \text{ steps}\cdot\text{day}^{-1}$ ;  $\text{STEPS5} = 10177 \text{ steps}\cdot\text{day}^{-1}$ ;  $\text{STEPS2} = 10338 \text{ steps}\cdot\text{day}^{-1}$ ). The lower number of steps at school in group A ( $\text{SKsteps} = 2375 \text{ steps}\cdot\text{day}^{-1}$ ) corresponds to the low number of steps during leisure time ( $\text{LEIsteps} = 4799 \text{ steps}\cdot\text{day}^{-1}$ ) and on weekend days. On the other hand, children from group B significantly ( $p < .001$ ) exceeded group A in the number of steps taken at school ( $\text{SKsteps} = 3296 \text{ steps}\cdot\text{day}^{-1}$ ) and outside of school ( $\text{LEIsteps} = 7426 \text{ steps}\cdot\text{day}^{-1}$ ) (Fig. 4). The smallest inter group difference in the criterion of STEPS is observed at school. The reason for such a small difference could be seen in school educational programs at monitored schools which, by their structure and content, do not take individual dif-

ferences between children fully under consideration and probably takes part in the reduction of the number of steps in physically more active children.

**Fig. 4**

The average number of steps (steps·day<sup>-1</sup>) – comparison of groups A (n = 49) and B (n = 151)



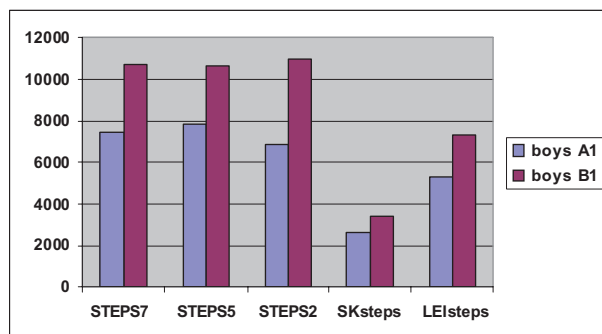
Legend:

STEPS7 – mean numbers of steps within the monitored week  
 STEPS5 – mean numbers of steps on weekdays  
 STEPS2 – mean numbers of steps on weekend days  
 SKsteps – mean numbers of steps on weekdays at school  
 LEIsteps – mean numbers of steps on weekdays in their leisure time

Boys from group B reached a higher mean number of steps during the monitored week (STEPS7 = 10705 steps·day<sup>-1</sup>), on weekdays (STEPS5 = 10632 steps·day<sup>-1</sup>), and on weekend days (STEPS2 = 10990 steps·day<sup>-1</sup>). Values found in group A were significantly lower ( $p < .001$ ), i.e. STEPS7 = 7483 steps·day<sup>-1</sup>, STEPS5 = 7857 steps·day<sup>-1</sup>, and STEPS2 = 6893.93 steps·day<sup>-1</sup>. In their leisure time outside school on weekdays, the number of steps found in boys from group B was almost one third higher ( $p < .001$ ) (LEIsteps = 7333 steps·day<sup>-1</sup>), when compared to their counterparts from group A (LEIsteps = 5338 steps·day<sup>-1</sup>). In spite of the significant difference ( $p < .02$ ) in the number of steps taken during their stay at kindergarten by groups A (SKsteps = 2656 steps·day<sup>-1</sup>) and B (3435 steps·day<sup>-1</sup>) we find differences in other monitored values of the STEP factor between these groups of boys to be considerably higher. The school regimen probably does not allow boys from group B to saturate sufficiently their need of locomotion activities and that is why they carry out these activities during weekdays outside school and on weekend days in particular (Fig. 5). Compared to the values of the number of steps outside school, a stay at kindergarten lowers the number of steps considerably (approximately by 50%) not only in more active boys from group B, but also in group A.

**Fig. 5**

The average number of steps (steps·day<sup>-1</sup>) – comparison of boys from groups A (n = 30) and B (n = 74)



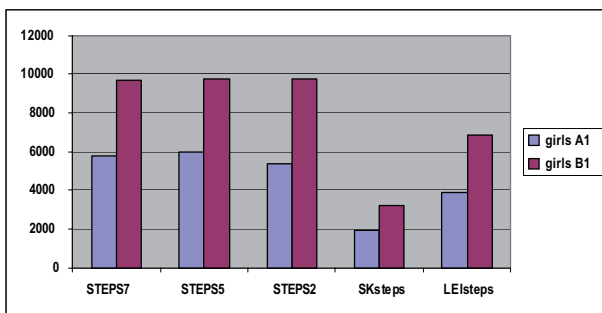
Legend:

STEPS7 – mean numbers of steps within the monitored week  
 STEPS5 – mean numbers of steps on weekdays  
 STEPS2 – mean numbers of steps on weekend days  
 SKsteps – mean numbers of steps on weekdays at school  
 LEIsteps – mean numbers of steps on weekdays in their leisure time  
 Boys A – the sample of boys who do not meet the health recommendations IAW the STEPS indicator  
 Boys B – the sample of boys who meet the health recommendations IAW the STEPS indicator

A significant difference ( $p < .001$ ) in the daily number of steps during the monitored week can be observed also in girls from group A (STEPS7 = 5764 steps·day<sup>-1</sup>) and B (STEPS7 = 9689 steps·day<sup>-1</sup>). Girls from group A reached values lower by almost one quarter ( $p < .001$ ) on weekdays (STEPS5 = 5968 steps·day<sup>-1</sup>), when compared to group B (STEPS5 = 9747 steps·day<sup>-1</sup>). In girls from group A, the number of steps taken during a weekend is even lower in comparison with weekdays (STEPS2 = 5381 steps·day<sup>-1</sup>), while these values are almost the same in group B (STEPS2 = 9721 steps·day<sup>-1</sup>). Thus, the significant difference ( $p < .001$ ) between groups A and B can be found also on weekend days. With regard to the young age of these children, their PA on weekend days is mostly affected by the life style of their family, the activity of their parents and the approach of parents to the education of their child. However, when taking the STEPS criterion into account, girls from group B (SKsteps = 3181 steps·day<sup>-1</sup>) are more active also at school ( $p < .001$ ), when compared to girls from group A (SKsteps = 1906 steps·day<sup>-1</sup>). In leisure time outside school, a significant difference ( $p < .001$ ) was found in steps between girls from group A (LEIsteps = 3899 steps·day<sup>-1</sup>) and B (LEIsteps = 6815 steps·day<sup>-1</sup>) similarly as in boys (Fig. 6). The number of steps taken during weekdays at school is also, in girls, approximately half-length in comparison with leisure time outside school.

**Fig. 6**

The average number of steps (steps·day<sup>-1</sup>) – comparison of girls from groups A (n = 19) and B (n = 77)



Legend:

STEPS7 – mean numbers of steps within the monitored week

STEPS5 – mean numbers of steps on weekdays

STEPS2 – mean numbers of steps on weekend days

SKsteps – mean numbers of steps on weekdays at school

LEIsteps – mean numbers of steps on weekdays in their leisure time

Girls A – the sample of girls who do not meet the health recommendations in the indicator of STEPS

Girls B – the sample of girls who meet the health recommendations in the indicator of STEPS

Tudor-Locke and Bassett (2004) assume 12,000 to 16,000 steps a day in children. Taking the STEPS criterion into account, seventy one children (35.5%) from the sample included in group A did not meet this health criterion. Thirty two (45.07%) of these were boys and thirty nine (54.93%) were girls. This result was probably influenced partly by the age of the children, because the above mentioned values for health criteria were developed for children from the age of six. The group of children meeting this criterion consisted of 129 (64.50%) children, seventy two (55.81%) of whom were boys and fifty seven (44.18%) were girls. It is possible to assume a rather positive trend of development in the daily number of steps with the growing age of children under conditions of maintaining dominant active transport to and from school and a gradual increase in their involvement in sport and children's organizations with respect to the interests of each child.

According to activity criteria for adults (Tudor-Locke, Hatano, Pangrazi, & Kang, 2008), the mean daily values reached in group B are classified as "active" and "somewhat active" or "less active" in group A. Jago et al. (2006) estimated that 8,000 steps per 60 minutes correspond to 60 minutes of moderate PA. Sigmund, Frömel and Neuls (2005) indicate 8,250–12,000 steps a day to be sufficient from the aspect of expected health benefits for pre-school children. Thus, in the STEPS criterion, the level reached could be classified as sufficient. However, it is necessary to perceive that, in pre-

school aged children, locomotion activities are not only a source for meeting the requirements for movement but also a means for the development of cognitive functions and an important stimulus for the socialization of a child. According to measures made by Sigmund, De Croix, Miklánková and Frömel (2006) and Sigmund, Miklánková, Mitáš, Sigmundová and Frömel (2007), the criteria for PA in children and youth decline rapidly in older age categories, especially after the beginning of compulsory school attendance. In girls, these values fall down to the level of an "inactive norm" of senior women with at least one factor of metabolic syndrome (Křenková, Daďová, Novotná, & Matoušková, 2006).

## CONCLUSIONS

Reviewing PA as a means for health support, there are many points of view and recommendations regarding the frequency, intensity and duration of PA from the aspect of benefits for the health of an individual. A relatively high percentage of pre-school children with hypokinetic behavior points to a necessity to target, in future research, factors causing this decrease and the area of interventional programs to promote PA under both school conditions and as a component of the life style of contemporary families. Extreme attention needs to be paid to unskillful children (Howell-Wechsler et al., 2000), children with special needs (Górny & Karásková, 2004; Janečka & Dostálová, 2007; Kudláček & Ješina, 2008) or children with problematic relationships to physical education and to enlighten them on possibilities of how to involve themselves in physical activities. Moreover, the problems of the undergraduate and postgraduate education of teachers with regard to the efficiency of school physical regimens and their influence in the PA level of children is deficiently assessed in the Czech Republic.

Our results confirm that a stay at kindergarten belongs to the relevant parts of a day from the aspect of children's physical activity in the sense of a very "problematic" part of a day, when the values of active energy expenditure are decreased almost by 50% even in children physically active outside the school. The same trend can be observed also in the number of steps. On the other hand, a kindergarten is a proper place for children with hypokinetic behavior, who can be activated by an adequate incidence of the fulfillment of a school physical regimen. In correspondence with school laws, kindergartens have at their disposal qualified pedagogical workers, certified tools and equipment and premises meeting the criteria of safety. The propriety and safety of the premises offered to children for play and locomotion activities of a spontaneous or organized character have been mentioned as a necessary determinant of an

increase in PA by many authors (Barnett, O'Loughlin, Gauvin, Paradis, & Hanley, 2006; European Healthy Heart Initiative, 2001; Louie & Chan, 2003; Mori, 2004; Sallis et al., 2001). It can be recommended to do further research in the field of PA in children of pre-school age and at the following primary school age in association with environmental stimuli to PA which can play a very important, motivating and activating role in relationship to physical activities.

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## POHYBOVÁ AKTIVITA U PŘEDŠKOLNÍCH DĚTÍ Z HLEDISKA ZDRAVOTNÍCH KRITÉRIÍ

(Souhrn anglického textu)

Hlavním cílem této studie bylo zhodnocení potenciálních rozdílů mezi skupinami předškolních dětí, které splňují a nesplňují zdravotní doporučení pro pohybové aktivity (PA) z hlediska takzvaných indikátorů pohybové aktivity (aktivní výdaj energie, počet kroků). Počet kroků byl měřen pedometry Yamax Digi-Walker SW-200 (Yamax Corporation, Tokio, Japonsko) a aktivní výdaj energie byl měřen akcelerometry Caltrac (Muscle Dynamics Fitness Network, Torrance, Kalifornie). Hodnocení PA z hlediska takzvaných zdravotních kritérií bylo uskutečněno dle kritérií Frömela, Novosada a Svozila (1999), kteří doporučují hodnoty takzvaných zdravotních kritérií PA. Při dosažení těchto kritérií je možné předpokládat, že PA má pozitivní účinky na zdravý



vývoj jednotlivce. Vzorek sestával z 200 předškolních dětí. Čtyřicet devět těchto dětí (30 chlapců a 19 dívek) bylo označeno jako skupina A (dětí, jež požadovaných doporučených hodnot nedosahovaly ani v jednom ze zdravotních kritérií PA). Skupina B (dětí, které dosahovaly požadovaných doporučených hodnot alespoň v jednom ze zdravotních kritérií PA) sestávala ze 151 dětí (74 chlapců a 77 dívek). K ověření statistického významu možných rozdílů mezi skupinami A a B a také mezi chlapci a děvčaty v rámci těchto skupin bylo použito testu Mann-Whitney. Ve všech sledovaných dnech týdne, stejně jako v obou sledovaných částech dne, byl u obou ukazatelů PA zaznamenán významný rozdíl ( $p < 0,001$ ) mezi skupinami A a B. Pokud jde o tyto proměnné, byly nejmenší rozdíly ( $p < 0,02$ ) pozorovány v době strávené ve škole. Naše výsledky potvrzují, že pobyt v mateřské škole náleží k důležitým částem dne z hlediska pohybové aktivity dětí ve smyslu velmi „problematické“ části dne, kdy se hodnoty aktivního výdaje energie a kroků snižují téměř o 50 % i u dětí pohybově aktivních mimo školu. Na druhou stranu je mateřská škola vhodná pro děti s hypokinetickou poruchou, jež může aktivovat adekvátní působení školního pohybového režimu.

*Klíčová slova: pohybová aktivita, předškolní věk, zdravotní doporučení, stimulace prostředím.*

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